Dr. Gillian Galford

Research Associate Professor
Gund Institute for Environment, Rubenstein School for Environment & Natural Resources
University of Vermont
VCC Data & Science Subcommittee, 07 July 2021

WWW.VTCLIMATE.ORG @VTCLIMATE
FB.ME/VERMONTCLIMATEASSESSMENT

Authors & Topics

- Co Investigators: Dr. Lesley-Ann Dupigny-Giroux, Dr. Joshua Faulkner, Dr. Laura Edling, Dr. Stephen Posner
- Lead Authors: Caitlin Crosset, Mahalia Clark, Danielle Cook, Kristin Raub, Ryan Ruggiero, Jess Wikle, Hanusia Higgins, Franni Hoag, Sarah Raimondi, Daphne Zencey, George Ni, Mollyrose Kelly-Gorham, Stephanie Clement
- Contributing authors: numerous
- Topics: Climate, Forests, Fisheries & Wildlife, Ag. & Food Systems, Water Resources, Community Development, Energy, Recreation & Tourism, Public Health

Climate Change is a cross-cutting issue

- Goal: VCA informs many different types of decision makers in Vermont, from legislators to land managers.
- What VCA findings are most important in the context of your work with the Council?
- Reducing Vermont's GHGs requires addressing complex socioeconomic systems, considering interactions and adaptations, and opportunities (and limitations) for mitigation options for nature based solutions. Ex: white tail deer
- There are interactions among climate impacts. Ex: LDD moth & multiple stressors.

Key messages

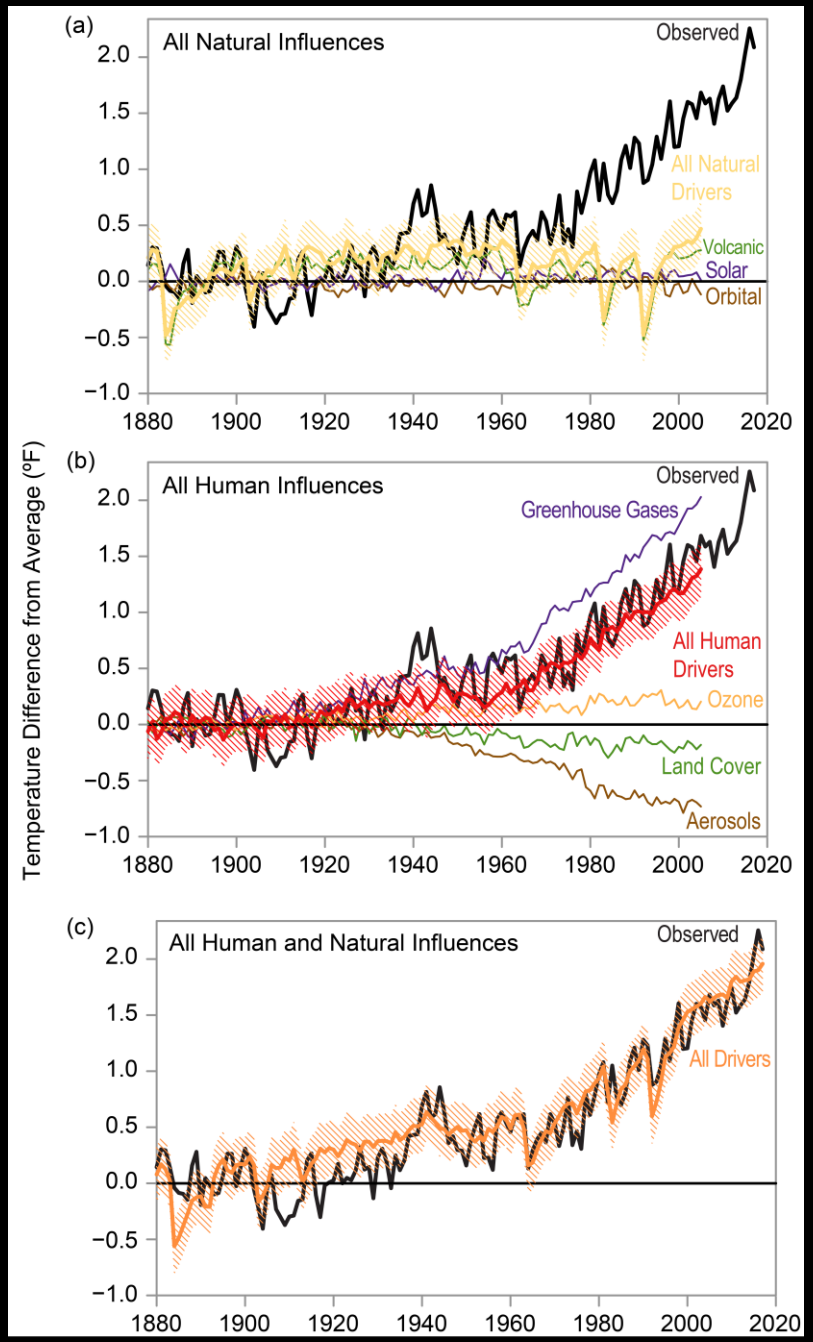
- Climate change is already affecting Vermont
- Positive and negative impacts of climate change are likely
- Solutions address complex socioeconomic systems to adapt, mitigate and build resilience

Agenda

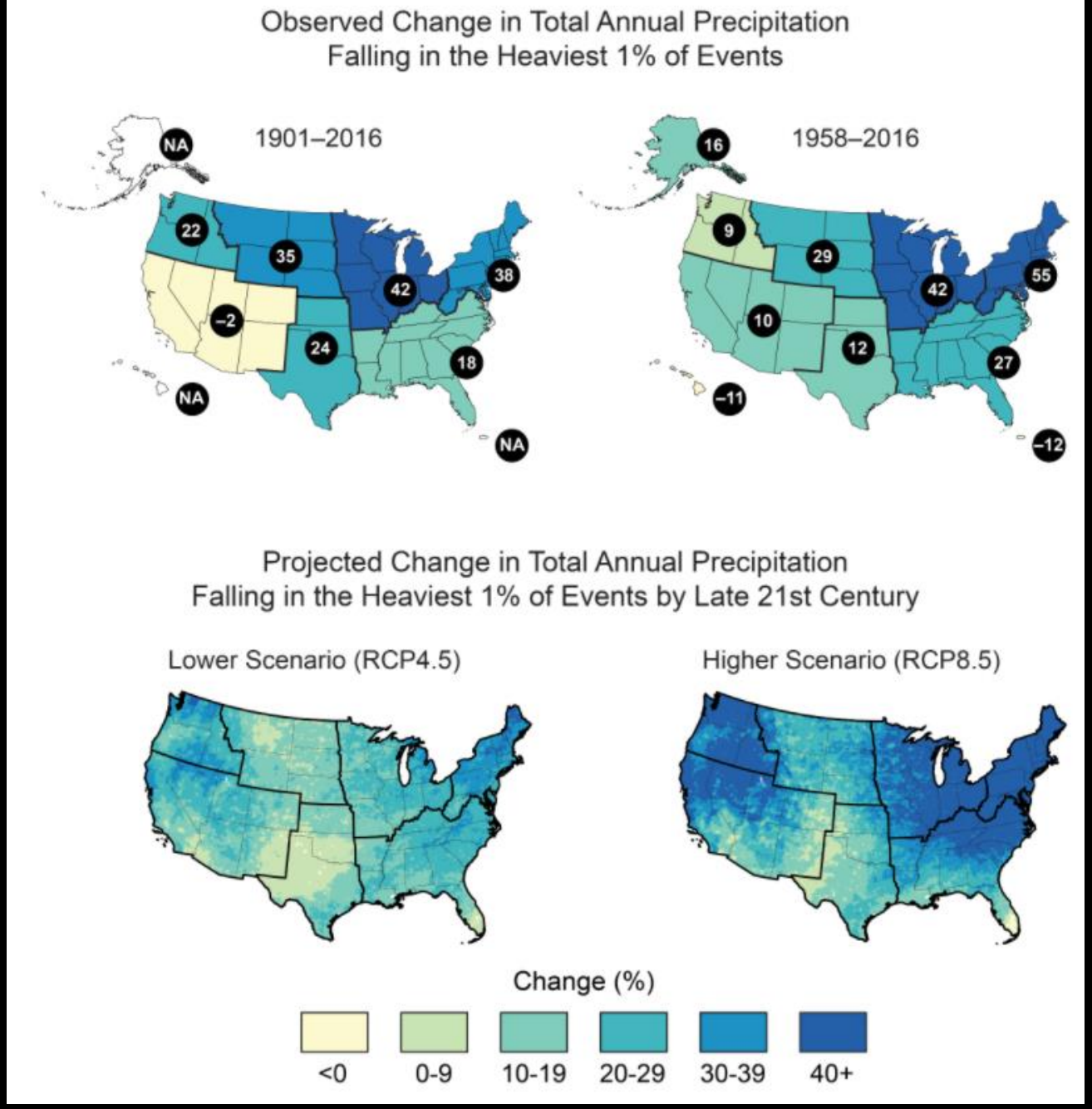
- Why do a state climate assessment?
- How is Vermont' climate changing?
- What are the impacts?
- Building resilience

Intl. and national context: What is climate change?

Changes in average weather conditions that persist over multiple decades or longer. Climate change encompasses both increases and decreases in temperature, as well as shifts in precipitation, changing risk of certain types of severe weather events, and changes to other features of the climate system. [See also global change]



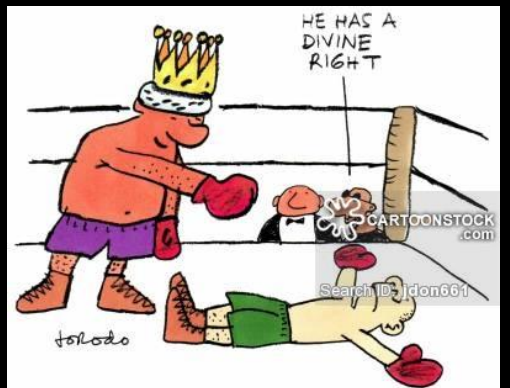
Source: National Climate Assessment 2018



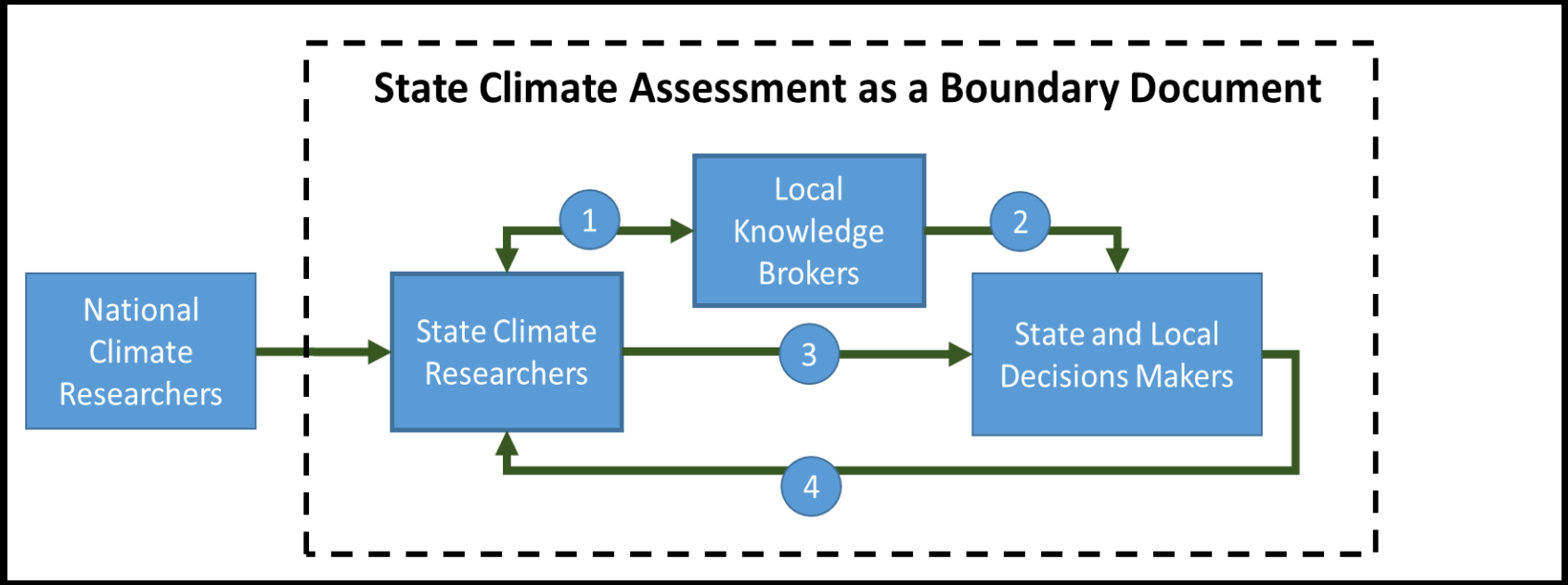
Source: National Climate Assessment 2018

VCA Framework for Uptake by Local Decision Makers

- **Credibility:** perception that information meets scientific standards
- **Salience:** degree of relevancy to the audience
- **Legitimacy:** perception of the information production process and its consideration of the values and perspectives of stakeholders



Framework: Uptake by Local Decision Makers



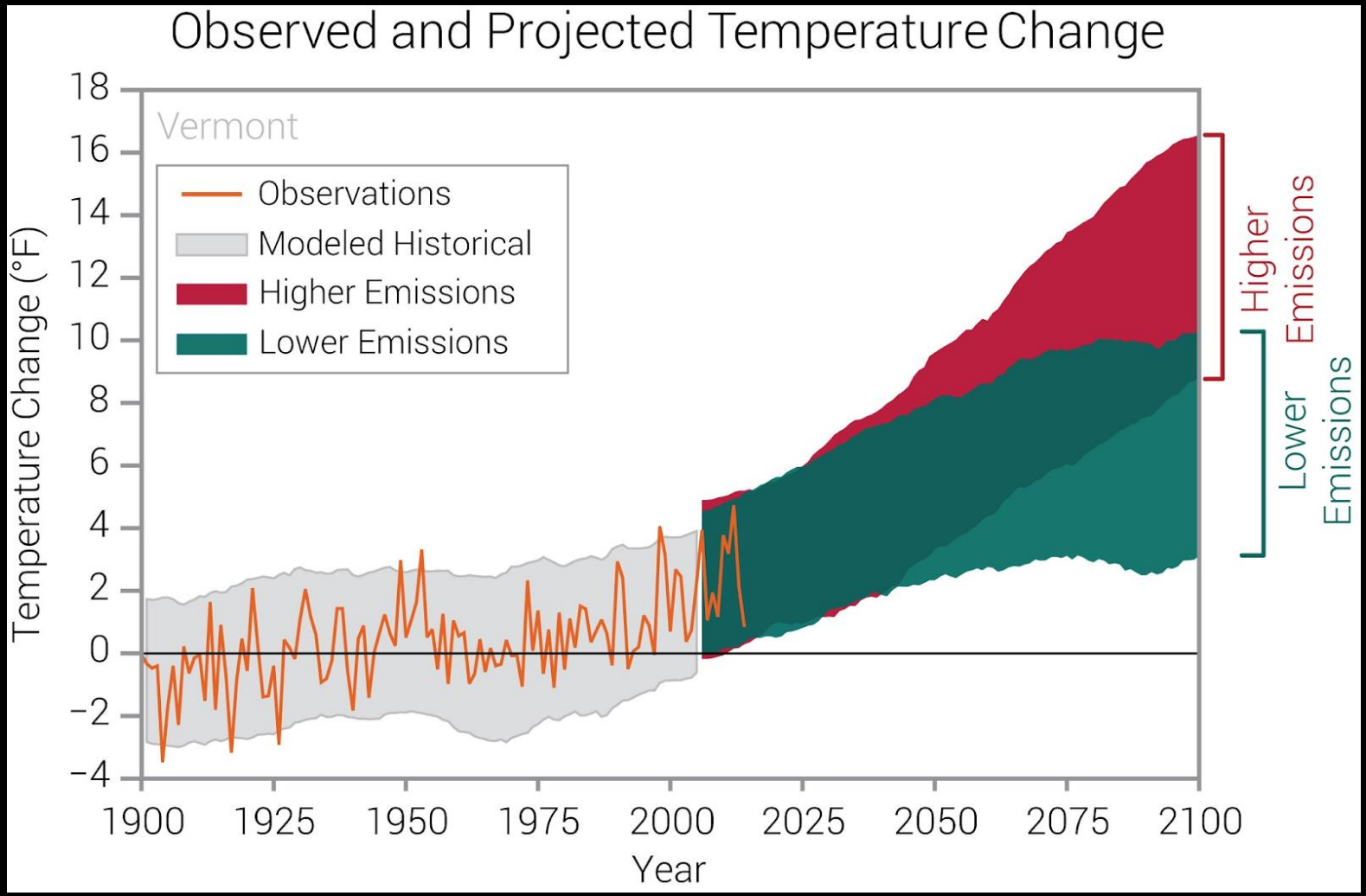
- Knowledge brokers are key players in research and communication
- Communication and processes build credibility, legitimacy and salience

Galford et al. Climatic Change 2016

Agenda

- Why do a state climate assessment?
- How is Vermont' climate changing?
- What are the impacts?
- Building resilience

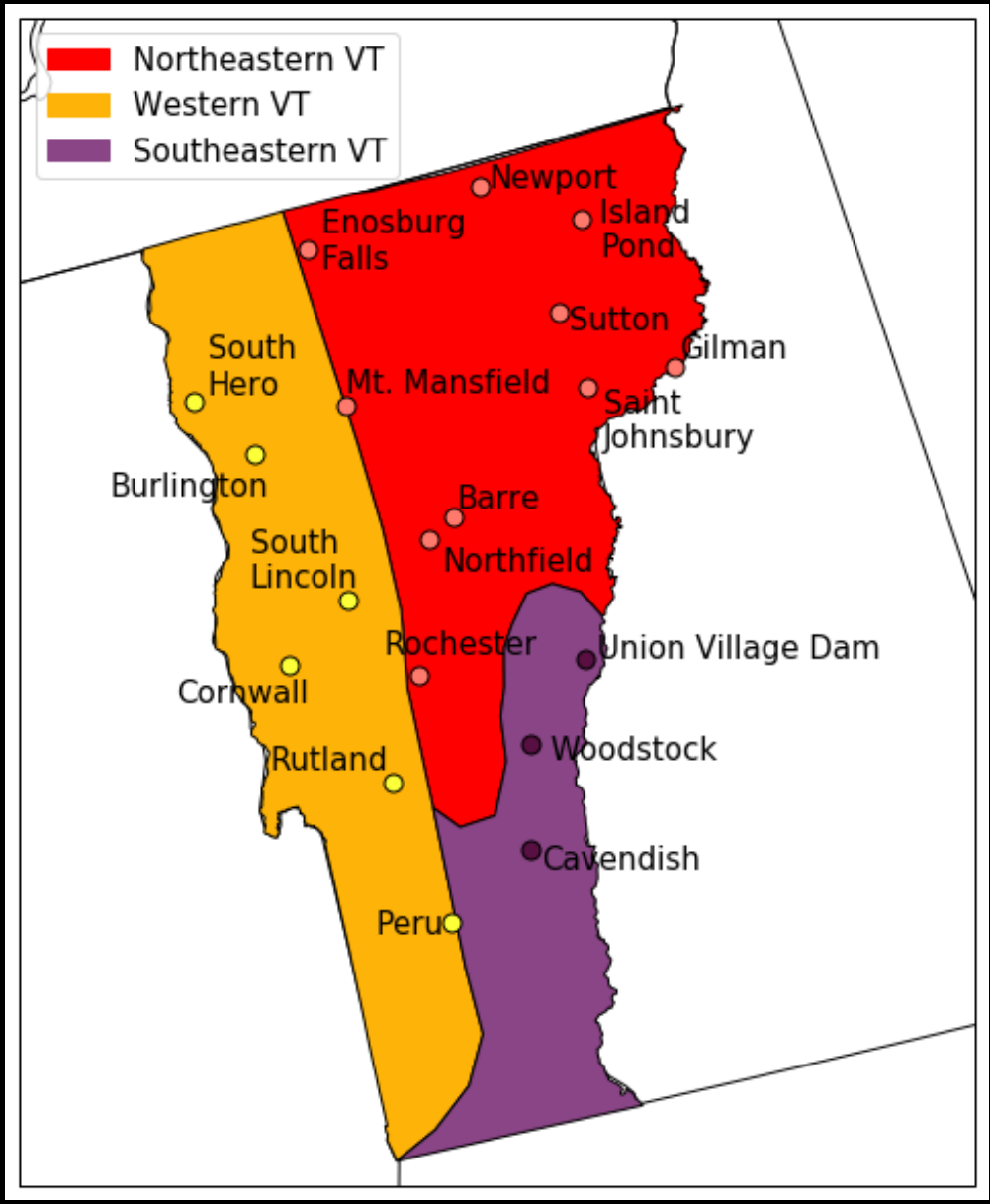
Where VT is headed



Source: Runkle et al. 2017

VT observations

- Recent trends strongest clue of near-term climate change
- Stations selected with NOAA/NWS
  - Spatial coverage
  - Data quality and consistency
  - Period of record



Source: VCA 2021, forthcoming

Vermont's Changing Climate--Evidence

- Warming across all seasons
- Increases in averages and extremes
  - Trend and total change values based on annual averages using available data for each year.
  - Trend values represent change per decade
  - **Bold*** indicates statistically significant to 95% confidence for trends (no estimate of significance for total change values).

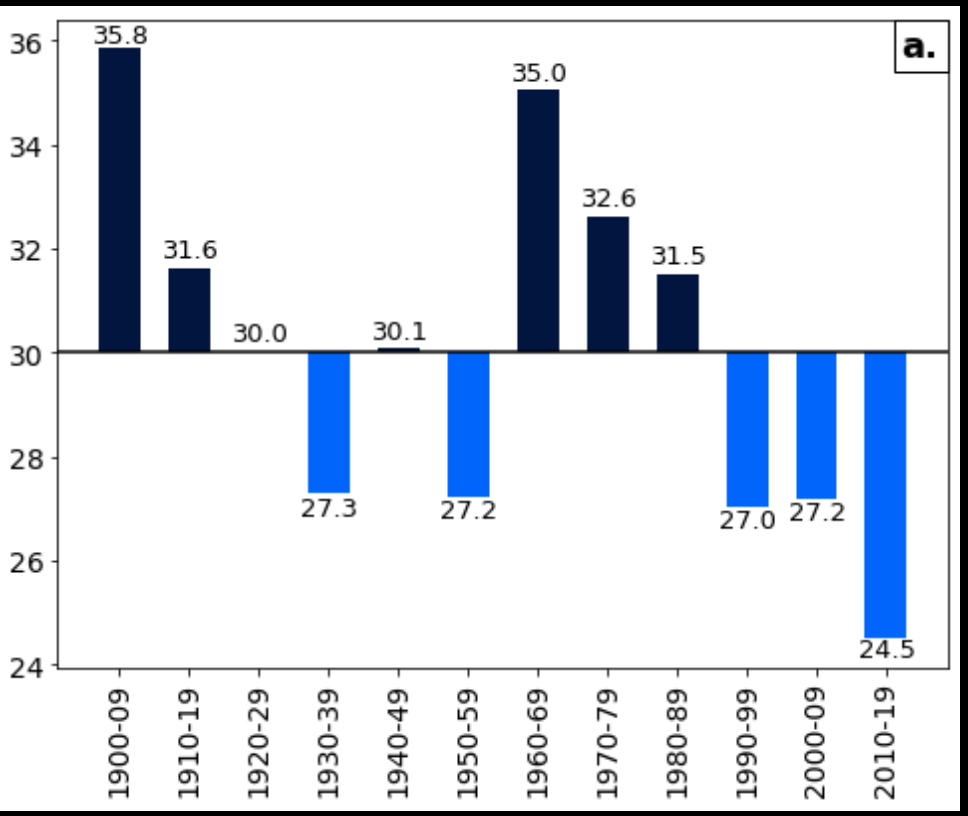
	Trend (per decade)			Total Change		
Avg. T. (ºF)	**1900–2020**	**1960–2020**	**1991–2020**	**since 1900**	**since 1960**	**since 1991**
Annual	+0.04	**+0.26***	+0.52	+1.95	+1.47	+1.04
Winter (DJF	+0.12	**+0.66***	+0.54	+3.35	+3.08	+0.90
Spring (MAM)	–0.03	+0.10	+0.15	+0.15	+0.94	+0.31
Summer (JJA)	+0.03	**+0.29***	+0.42	+1.45	+1.84	+0.92
Fall (SON)	–0.001	**+0.23***	**+0.75***	+1.59	+1.04	+1.80
Avg. Max. T. (ºF)	–0.06	**+0.18***	+0.51	+1.06	+1.04	+0.84
Avg. Min.T. (ºF)	**+0.15***	**+0.47***	**+0.70***	+2.79	+2.63	+1.33
Days Max. T.>90ºF	–0.01	+0.11	+0.48	+1.49	+1.19	+1.32
Days Min. T.>70ºF	**+0.04***	**+0.20***	**+0.48***	+1.14	+1.51	+1.15
Days Max. T.<0ºF	**–0.63***	**–2.08***	–3.04	–10.81	–10.01	–3.97
Winter Days Max. T.>50ºF	**+0.12***	**+0.31***	–0.04	+1.85	+1.82	–0.17

Source: Vermont Climate Assessment 2021

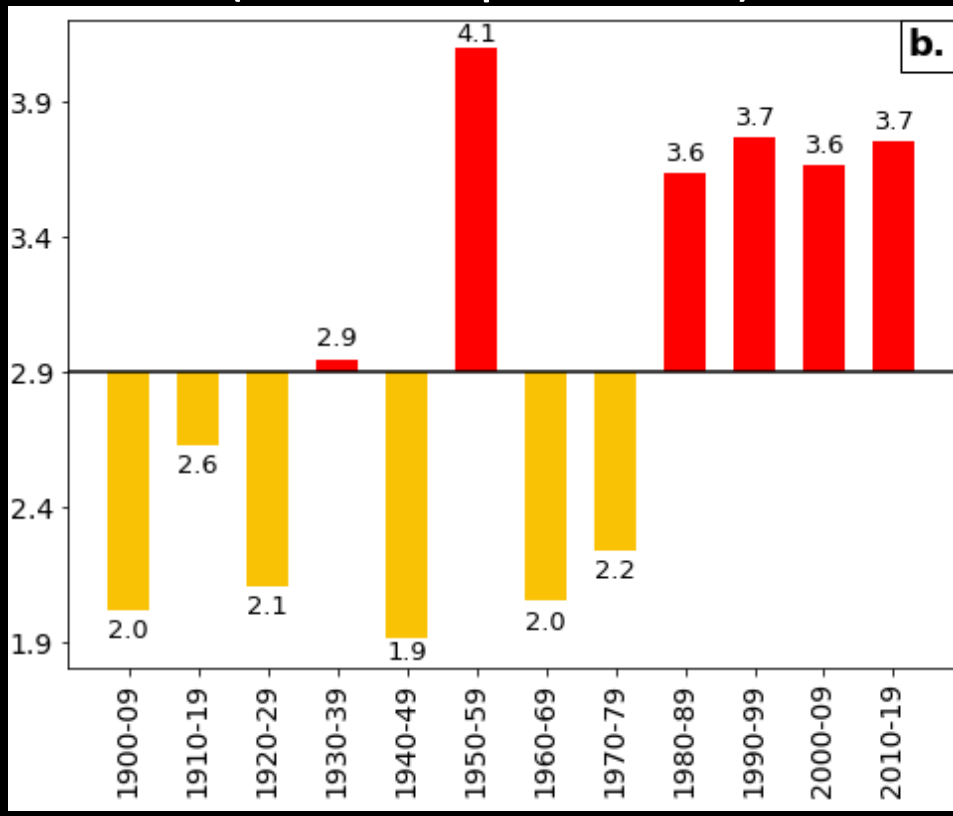
< -5 | -5 – -2 | -2 – -0.5 | -0.5 – 0 | 0 – 0.5 | 0.5 – 2 | 2 – 5 | > 5

Winter: Less cold, more warm days

COLD DAYS
(Max Temp <= 0° F)



WARM WINTER DAYS
(Max Temp >= 50° F)

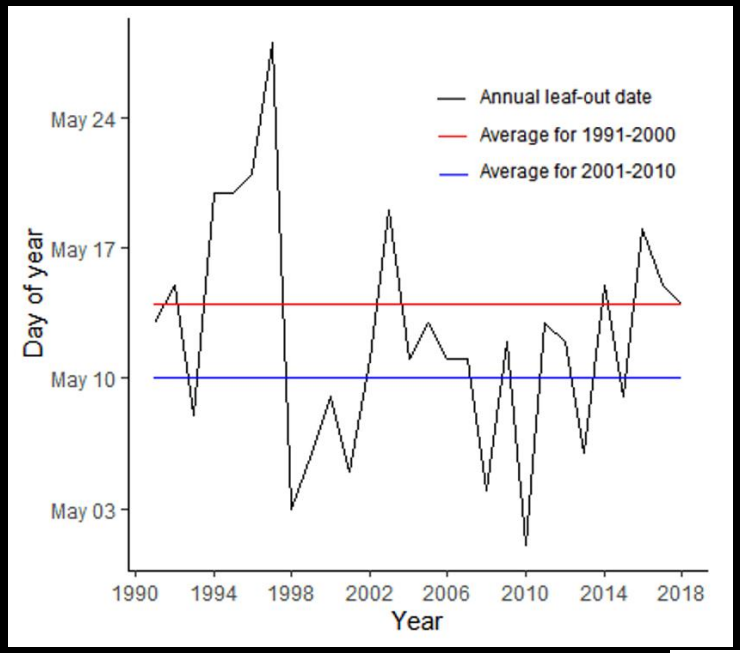


Source: Vermont Climate Assessment 2021

Forests, white-tailed deer, and hunting

- Forests, and their role in carbon mitigation, are important to our climate future White-tailed deer are a beloved species in Vermont, but also present a management challenge under climate change.
- Current deer populations are limited by winter intensity
- Projected warming is likely to boost Vermont's deer herd, which in turn will increase pressure on forest regeneration.
- Today, hunting helps keep Vermont's deer herd balanced.
- But, the future interest in hunting among Vermonters is uncertain, a potential challenge for managers stewarding the state's deer and forests under climate change.

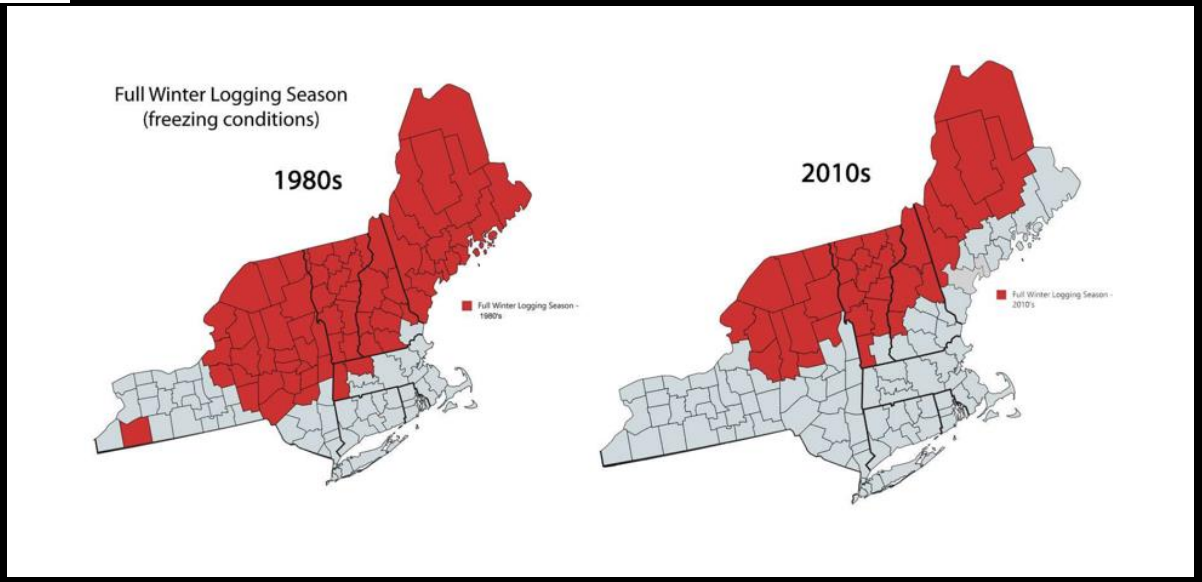
Source: Vermont Climate Assessment 2021; photo: J. Morse



Average annual leaf-out date for sugar maples in Underhill, VT (Halman and Wilmot, 2017).

Timing matters too.

- Forest uses (e.g., timber, sugar) are important for carbon management and livelihoods

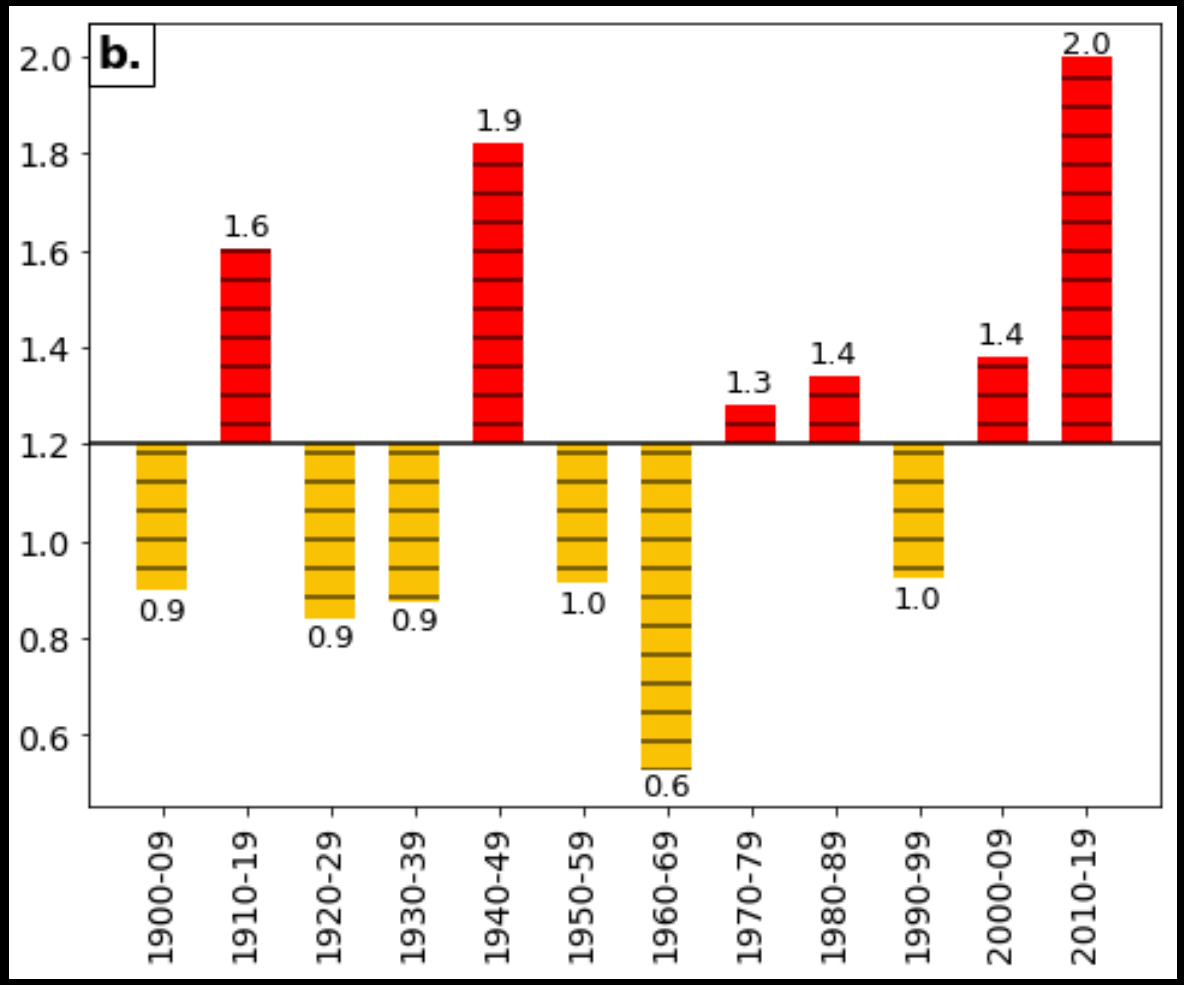


Length of winter logging season from 1980s to 2010s (Bick et al., 2019)

Hot summer nights more common

WARM NIGHTS

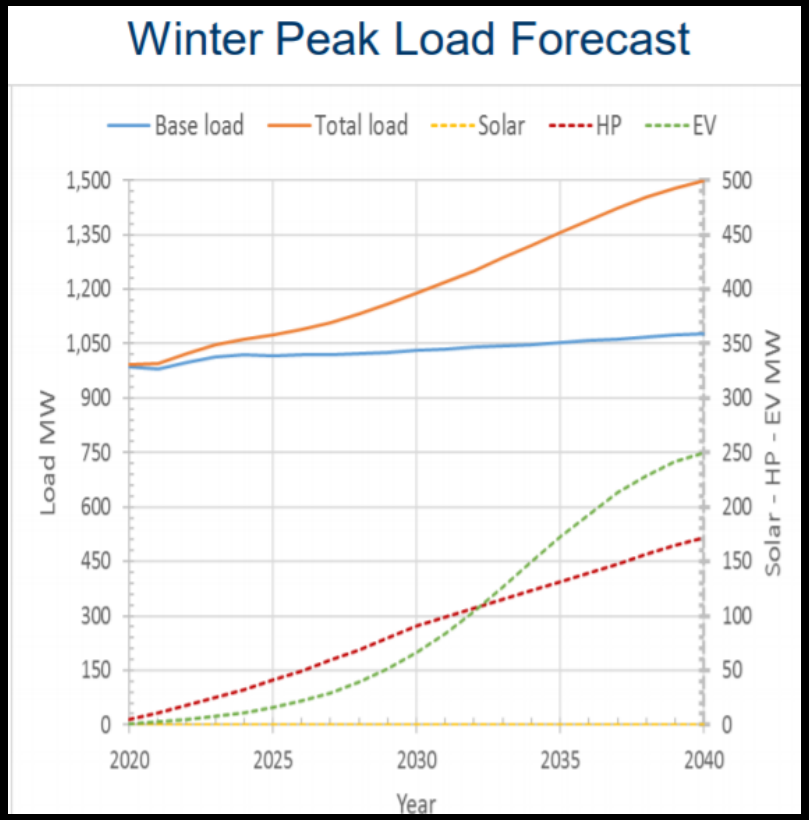
(Min Temp >= 70° F)

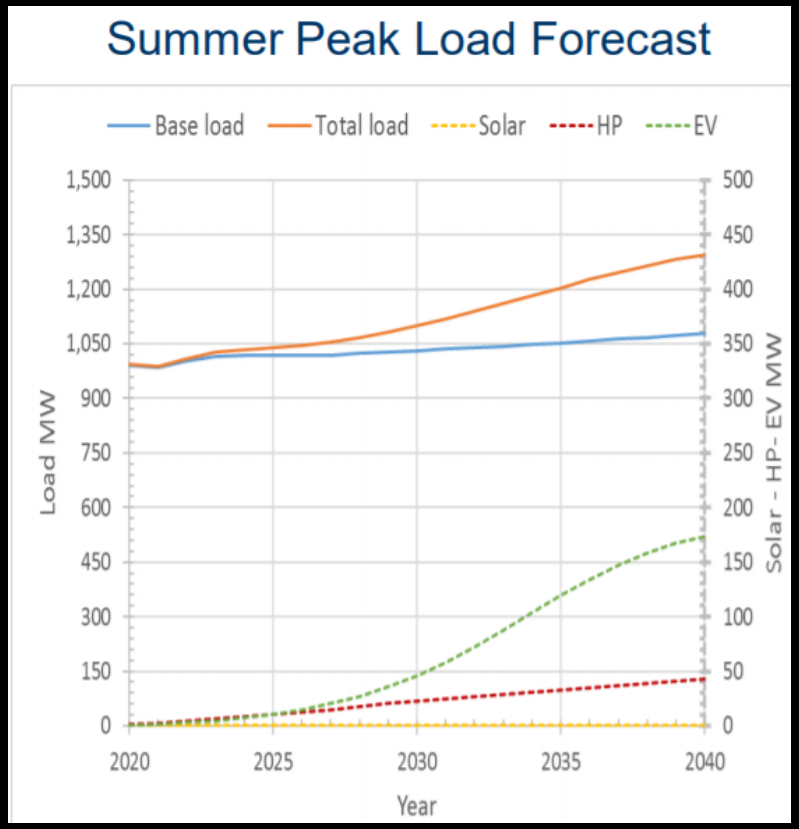


Source: Vermont Climate Assessment 2021

Seasonal changes in electricity demand

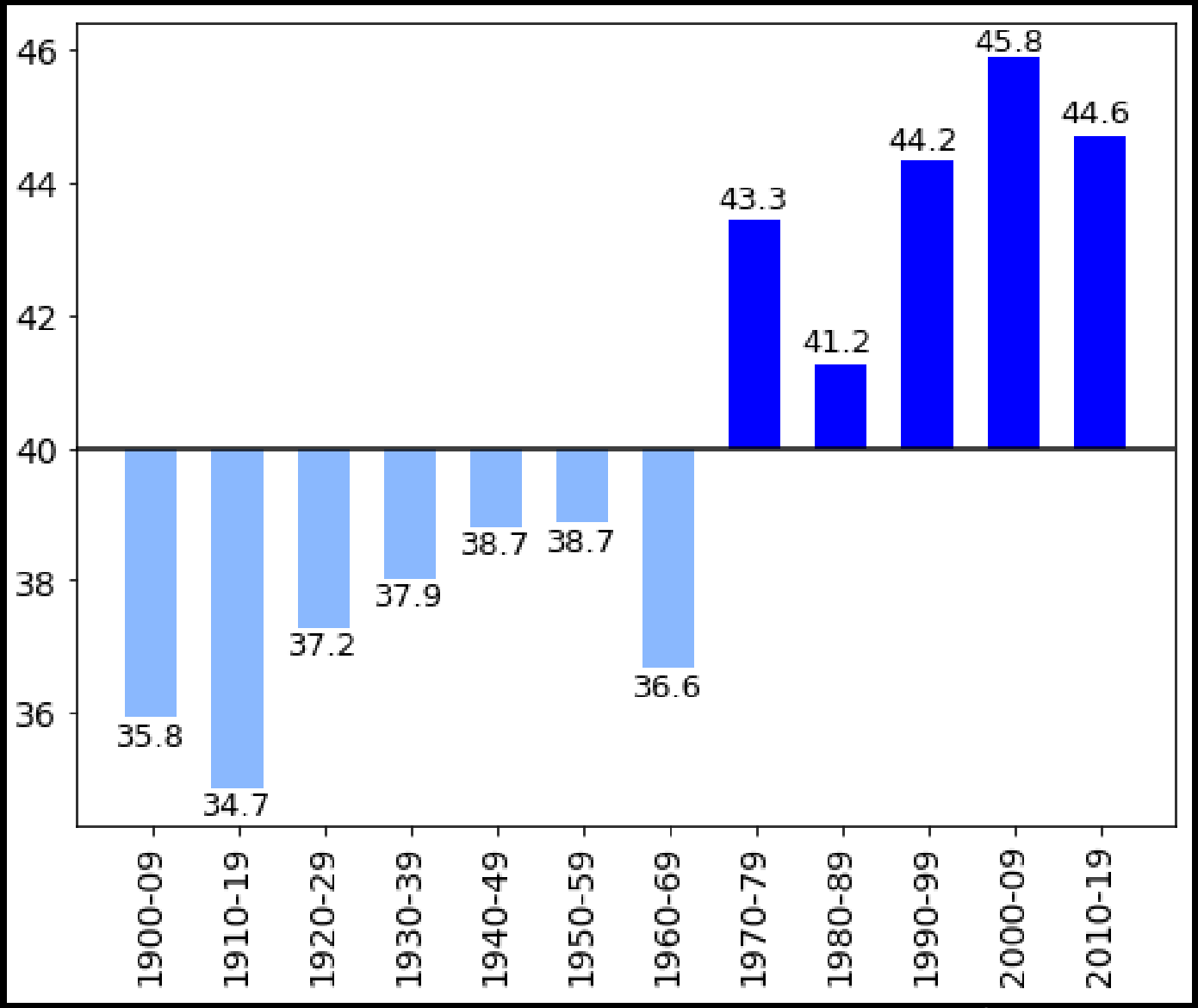
- Shifting sources highlight complexities of climate and society





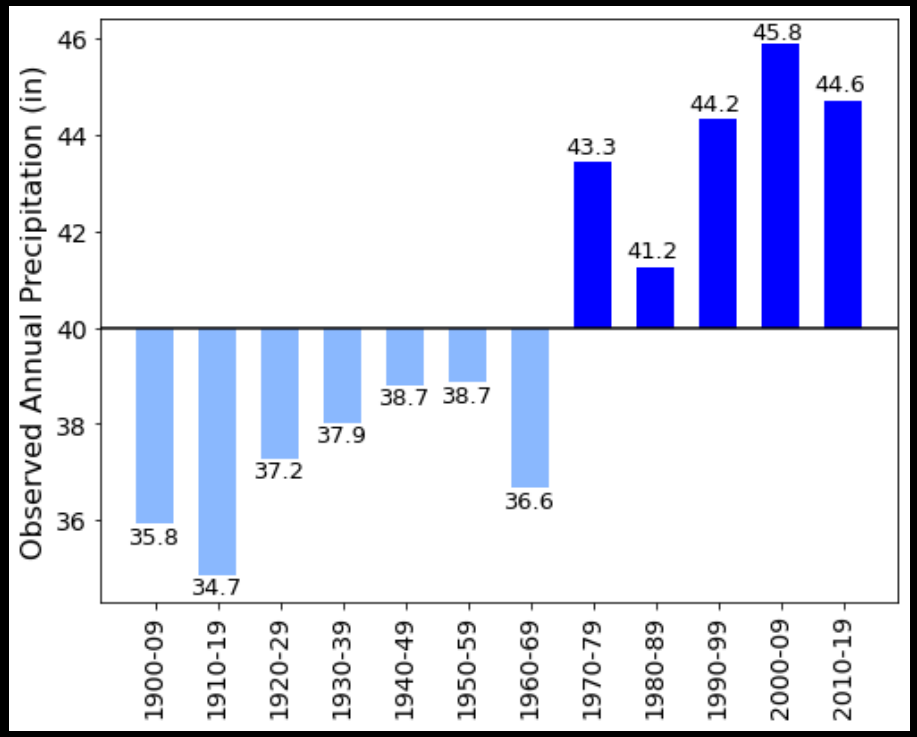
Source: VELCO

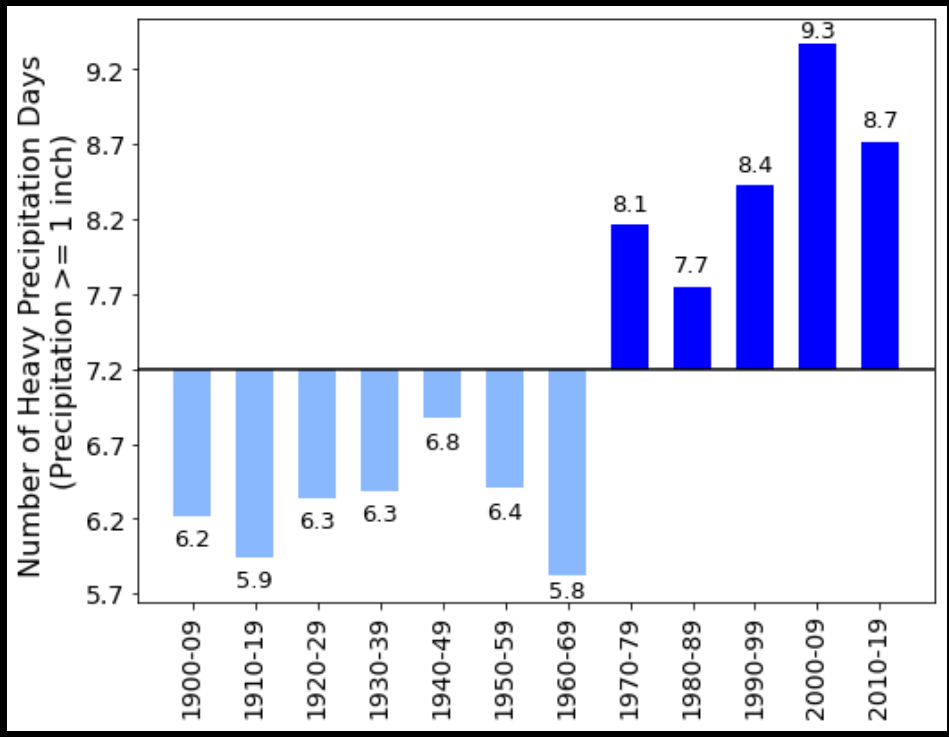
Annual Precip (inches): More water



Source: Vermont Climate Assessment 2021

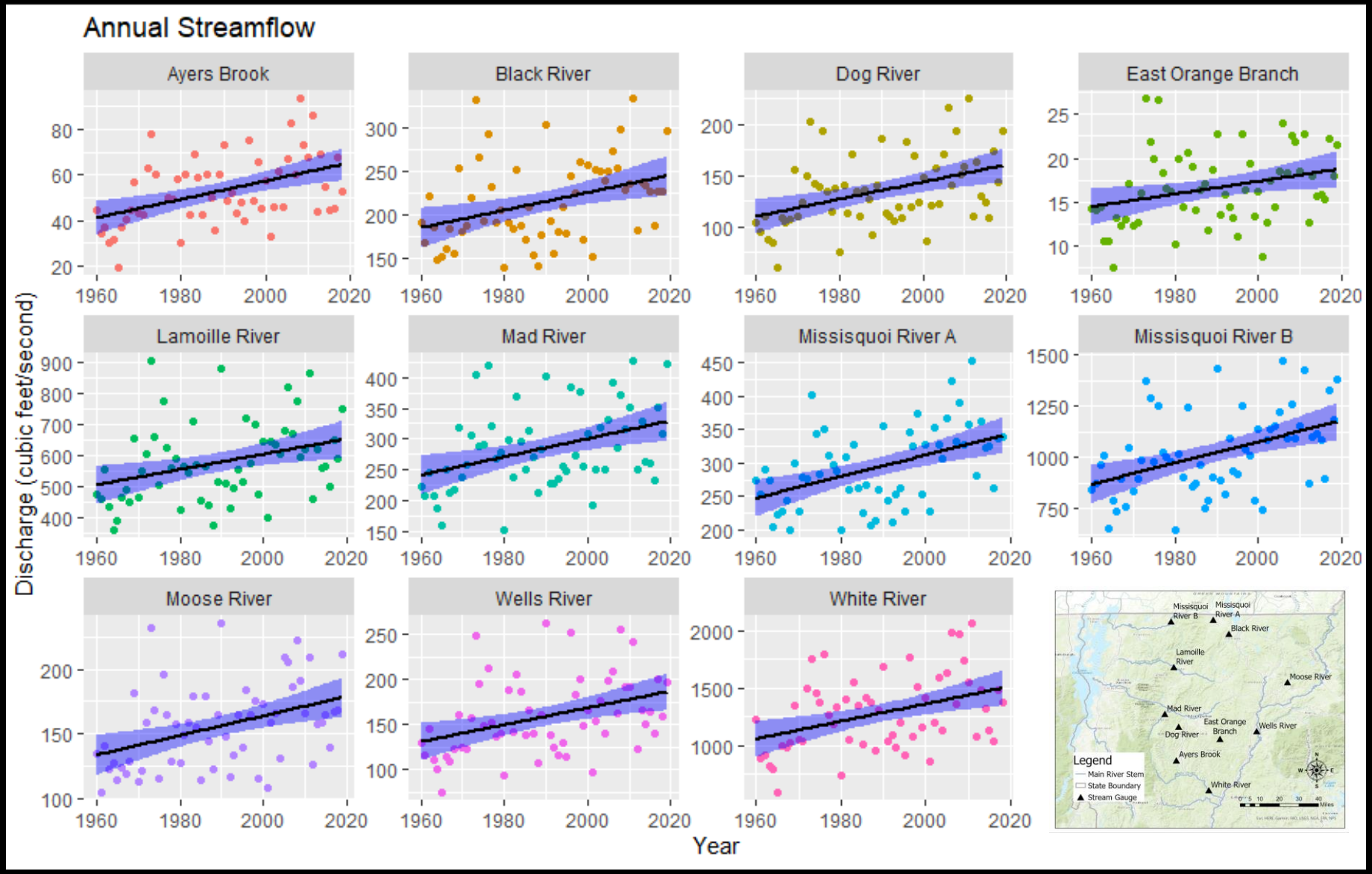
More water (and in bigger storms)





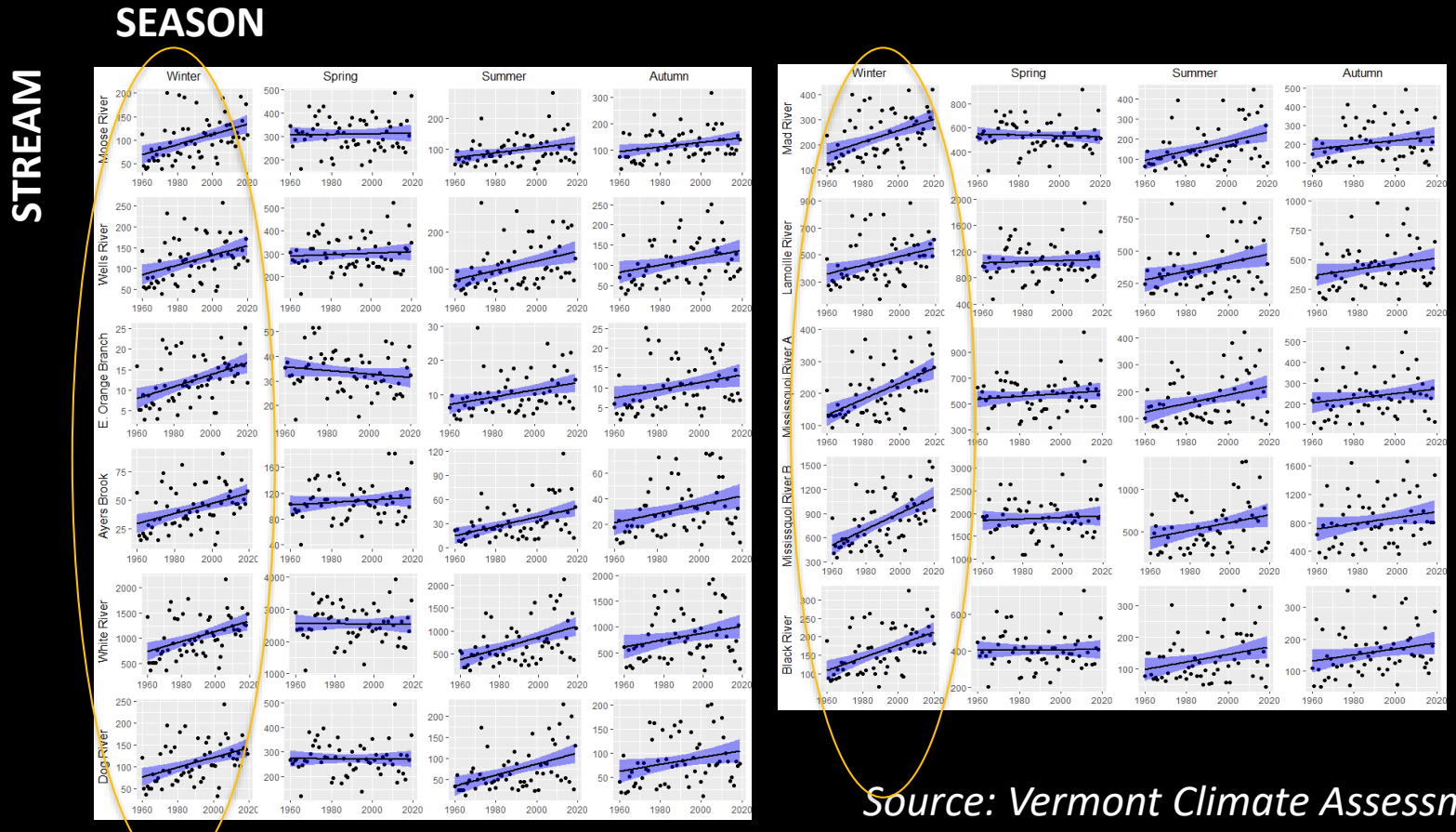
Source: Vermont Climate Assessment 2021

VT Rivers and streams



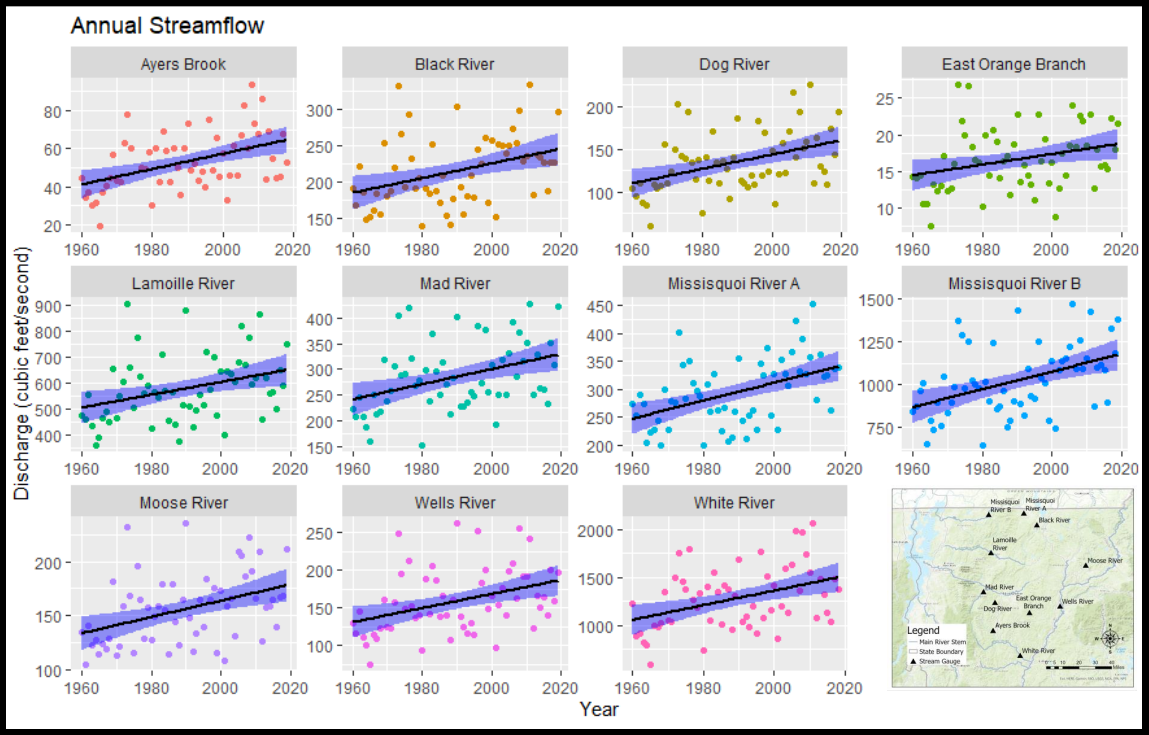
Seasonal river flow increasing all seasons but spring

- February Median Flow, a measurement used by ski areas to collect water for snowmaking, has steadily increased across Vermont.

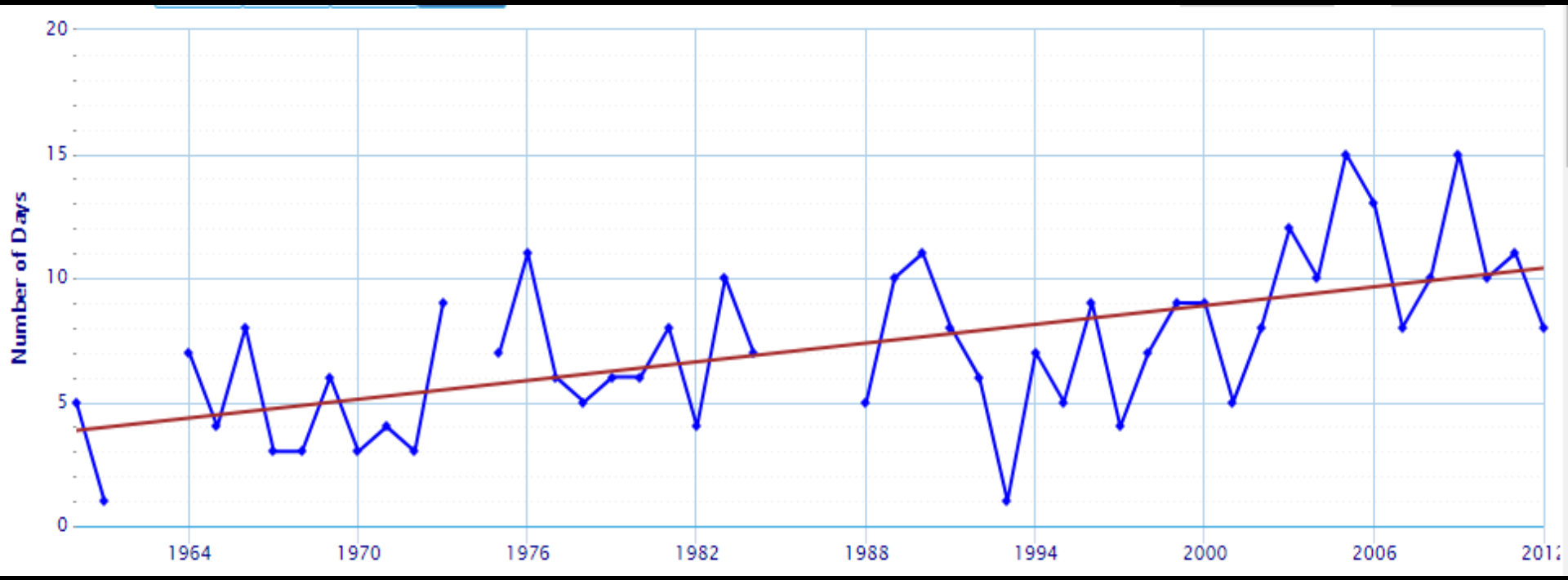


Source: Vermont Climate Assessment 2021

High flows impact ag & ecosys.

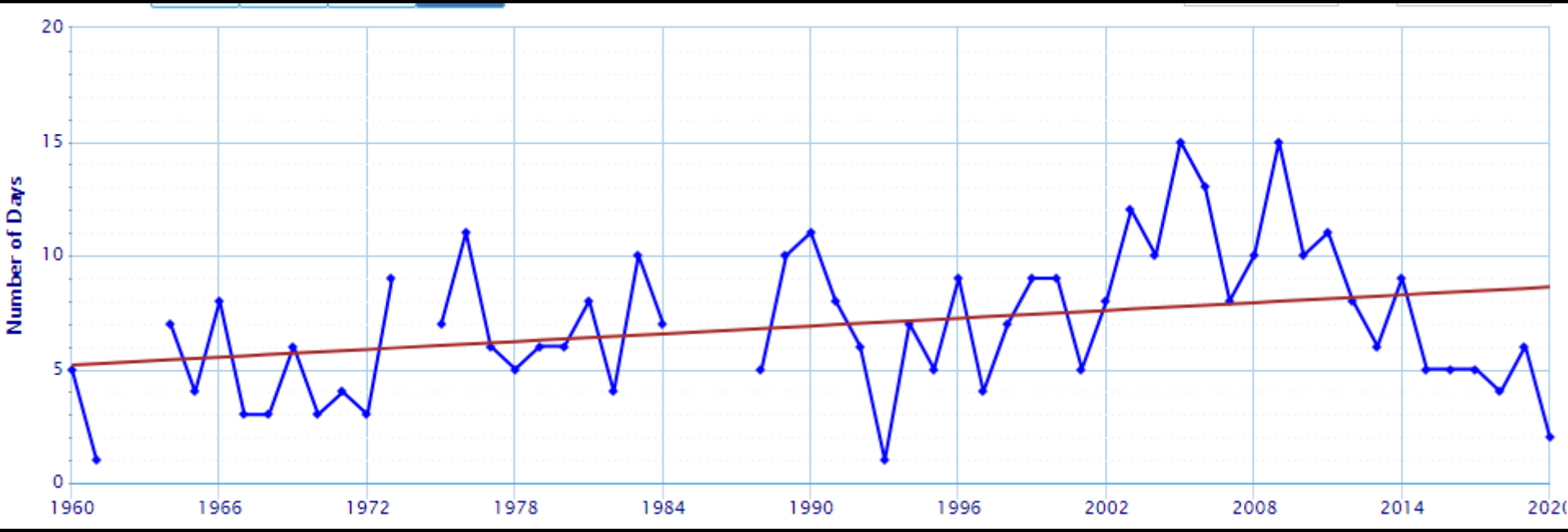


Days of heavy precipitation (RUT)



Source: NOAA/NWS, Vermont Climate Assessment 2014

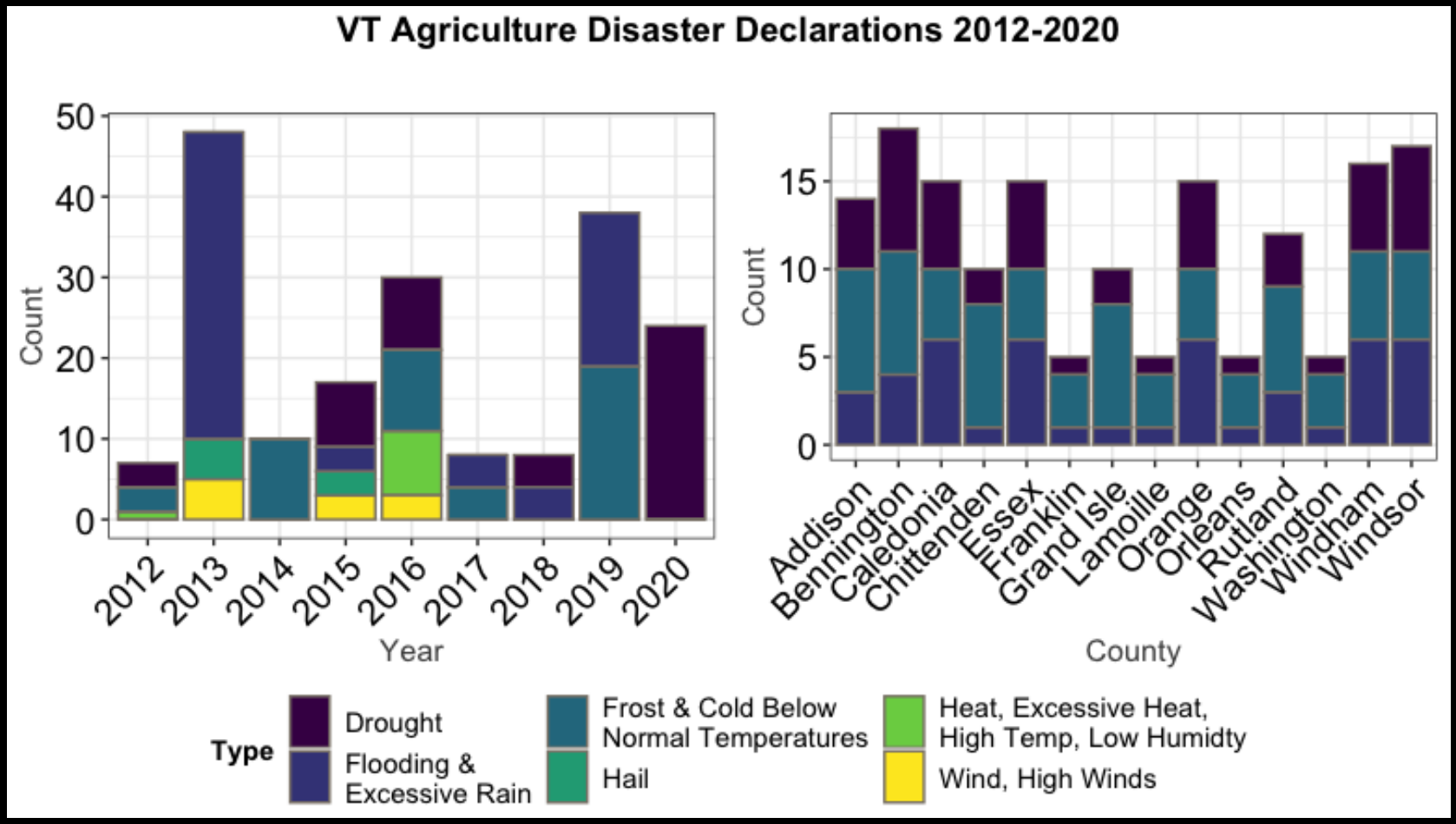
… but also more variability & dry spells (RUT)



Source: NOAA/NWS, Vermont Climate Assessment 2021

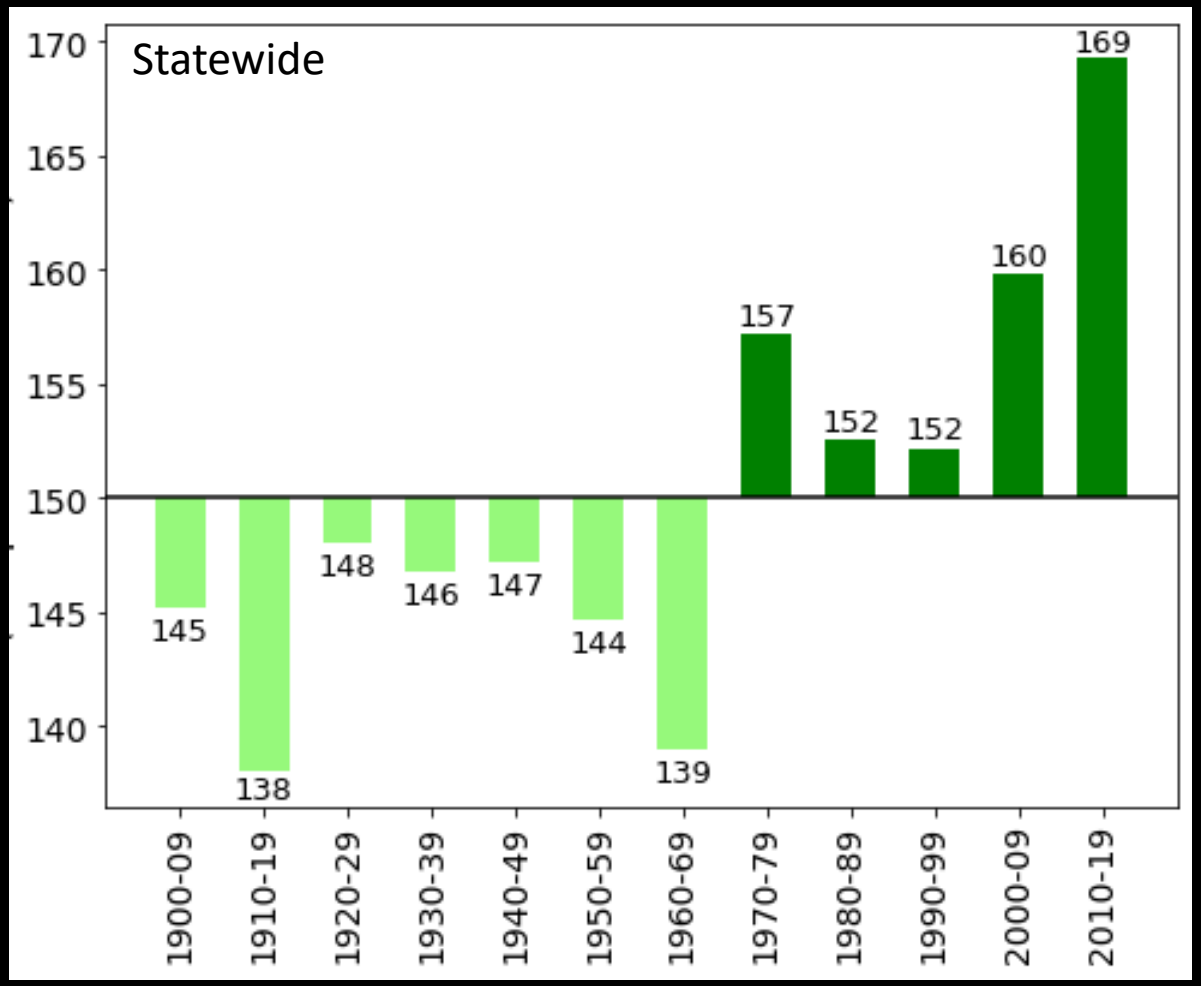
Climate impacts

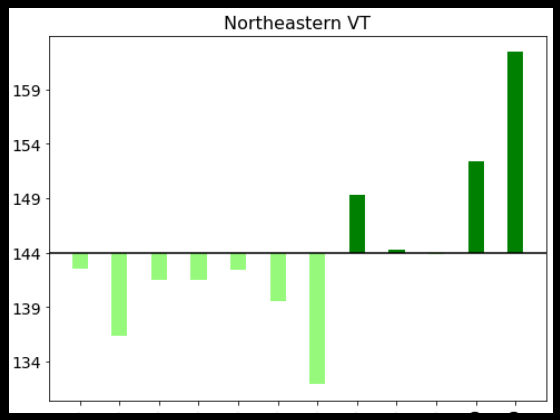
- Ex: USDA reported weather-related crop losses

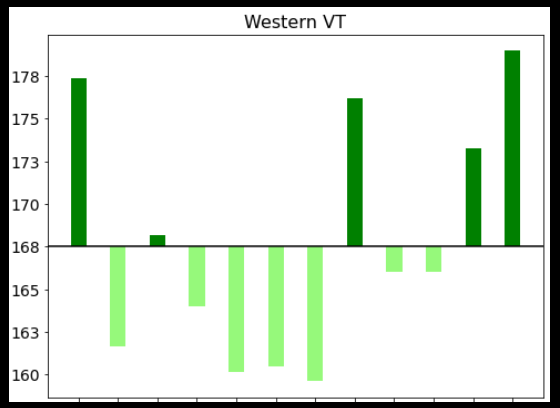


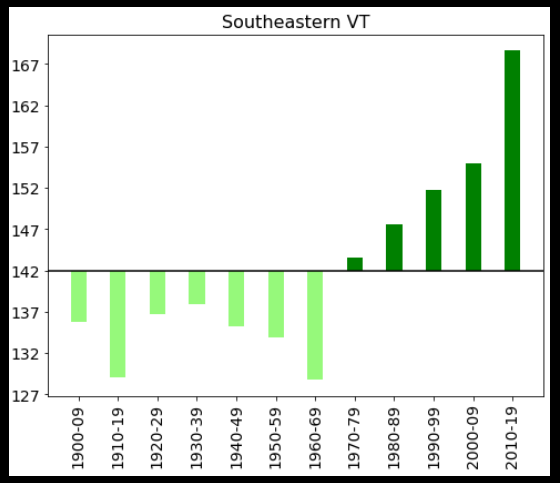
Lengthening growing season

Consecutive freeze-free days
(Min Temp >= 28° F)





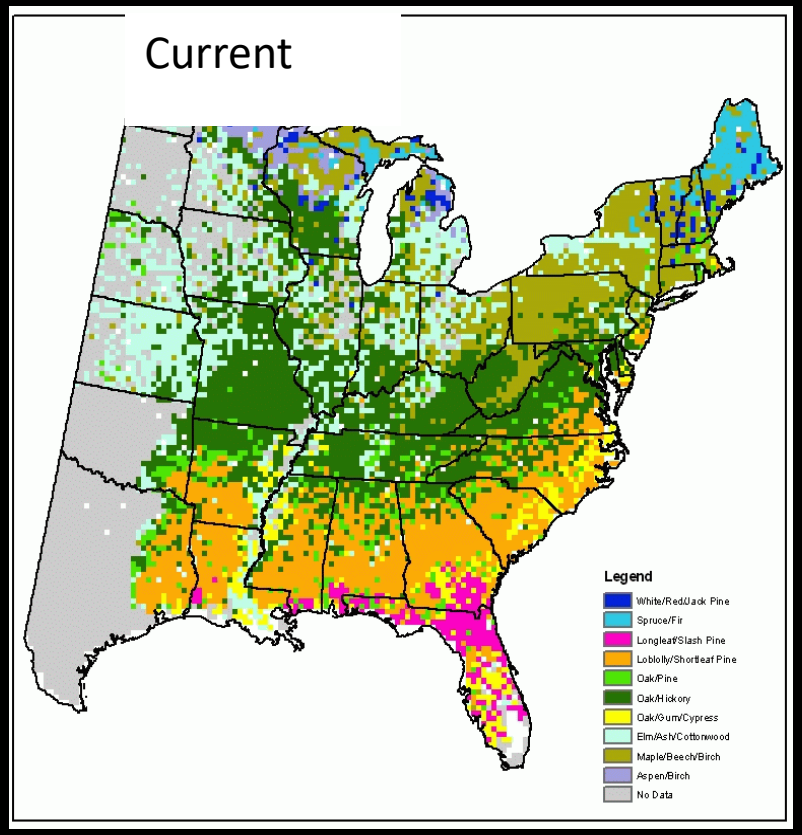


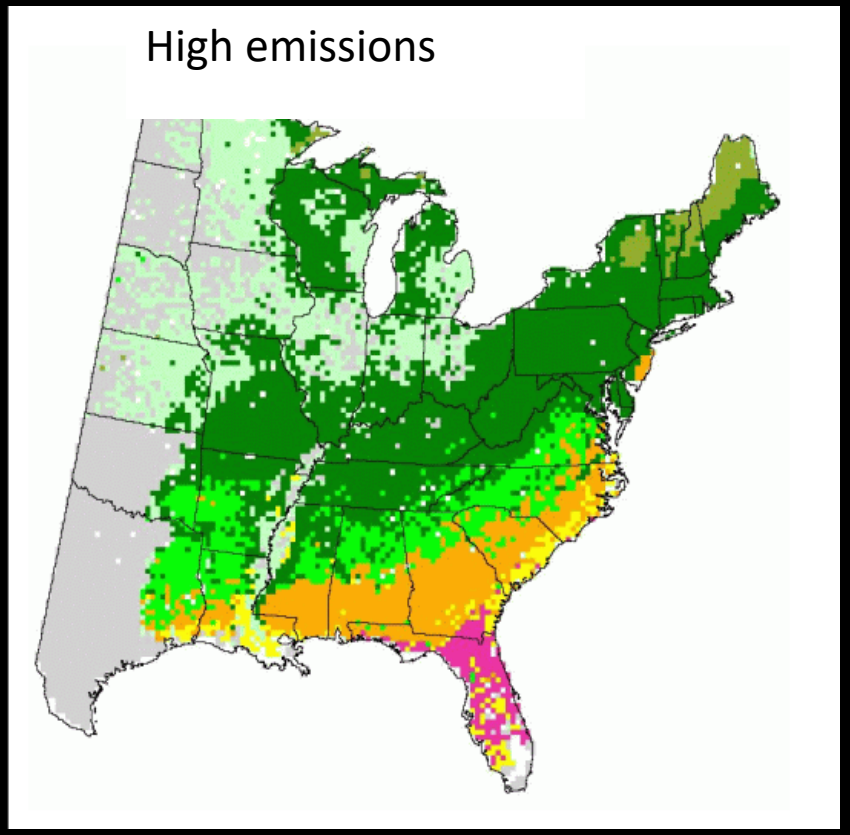


Source: Vermont Climate Assessment 2021

Shifting forests

Forest types and habitats will change with climate *(Peters et al., 2020).*





Agenda

- Why do a state climate assessment?
- How is Vermont' climate changing?
- What are the impacts?
- Building resilience

Key messages

- Climate change is already affecting Vermont
- Positive and negative impacts of climate change are likely
- Risk management is a good approach
- Building resilience today will help us thrive in the future

Key messages

- Climate change is already affecting Vermont
- Positive and negative impacts of climate change are likely
- Solutions address complex socioeconomic systems to adapt, mitigate and build resilience